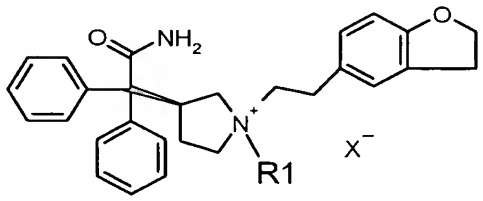
Claims

1. A quaternary ammonium compound of formula I



and any stereoisomers thereof, wherein

R_1 is selected from C_1-C_6 alkyl, -CH_2-(C_1-C_4 alkenyl), and –CH_2-(C_1-C_6 alkynyl), each of which is optionally substituted with a group selected from phenyl, C_1-C_4 alkoxy, and hydroxyl; and

X represents an anion of a pharmaceutically acceptable acid.

2. The compound of claim 1, wherein X is selected from the group consisting of the anions of the following acids: tartaric, hydrochloric, hydrobromic, hydroiodic, sulfuric, phosphoric, nitric, citric, methanesulfonic, CH_3-$(CH_2)_n$-COOH where n is 0-4, HOOC-(CH_2)n-COOH where n is 1-4, HOOC-CH=CH-COOH, and benzoic.

3. The compound of claim 1, wherein X is selected from the group consisting of iodide, bromide, and chloride.

4. The compound of claim 1, wherein X is iodide.

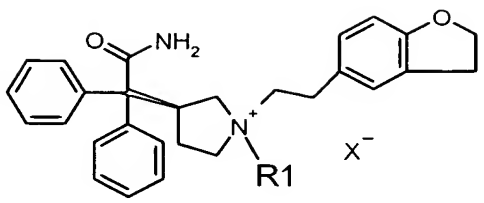
5. The compound of claim 1, wherein X is bromide.

6. The compound of claim 1, wherein X is chloride.

7. The compound of claim 1, wherein R_1 is methyl.

8. A compound (3S)-3-(2-amino-2-oxo-1,1-diphenylethyl)-1-[2-(2,3-dihydro-1-benzofuran-5-yl)ethyl]-1-methylpyrrolidinium iodide.

9. A pharmaceutical composition comprising a therapeutically effective amount of a quaternary ammonium compound of formula I



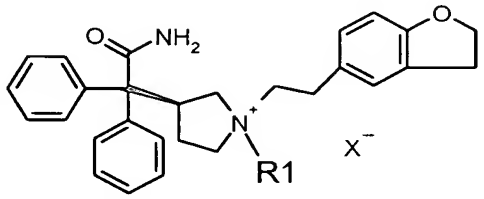
and any stereoisomers thereof, wherein

R_1 is selected from C_1-C_6 alkyl, -CH_2-(C_1-C_4 alkenyl), and –CH_2-(C_1-C_6 alkynyl), each of which is optionally substituted with a group selected from phenyl, C_1-C_4 alkoxy, and hydroxyl; and

X represents an anion of a pharmaceutically acceptable acid.

10. The pharmaceutical composition of claim 9, wherein the pharmaceutical composition further comprises a suitable pharmaceutical carrier.

11. A method of treating asthma in a mammal, comprising administering a therapeutically effective amount of a quaternary ammonium compound of formula I to a mammal in need of such a treatment, wherein the compound of formula I has the structure

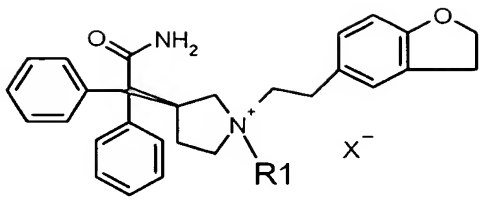


and any stereoisomers thereof, wherein

R_1 is selected from C_1-C_6 alkyl, -CH_2-(C_1-C_4 alkenyl), and –CH_2-(C_1-C_6 alkynyl), each of which is optionally substituted with a group selected from phenyl, C_1-C_4 alkoxy, and hydroxyl; and

X represents an anion of a pharmaceutically acceptable acid.

12. A method of treating chronic obstructive pulmonary disease in a mammal, comprising administering a therapeutically effective amount of a quaternary ammonium compound of formula I to a mammal in need of such a treatment, wherein the compound of formula I has the structure

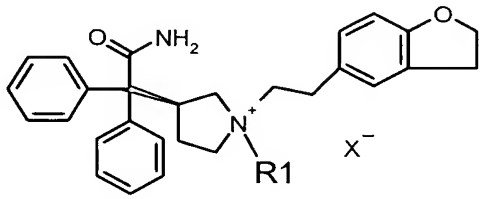


and any stereoisomers thereof, wherein

R_1 is selected from C_1-C_6 alkyl, -CH_2-(C_1-C_4 alkenyl), and –CH_2-(C_1-C_6 alkynyl), each of which is optionally substituted with a group selected from phenyl, C_1-C_4 alkoxy, and hydroxyl; and

X represents an anion of a pharmaceutically acceptable acid.

13. A method of treating allergic rhinitis in a mammal, comprising administering a therapeutically effective amount of a quaternary ammonium compound of formula I to a mammal in need of such a treatment, wherein the compound of formula I has the structure

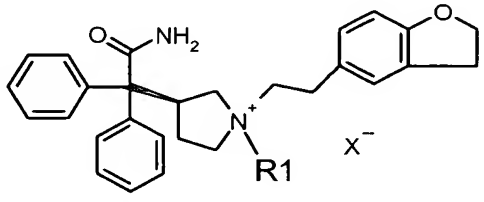


and any stereoisomers thereof, wherein

R_1 is selected from C_1-C_6 alkyl, -CH_2-(C_1-C_4 alkenyl), and –CH_2-(C_1-C_6 alkynyl), each of which is optionally substituted with a group selected from phenyl, C_1-C_4 alkoxy, and hydroxyl; and

X represents an anion of a pharmaceutically acceptable acid.

14. A method of treating infectious rhinitis in a mammal, comprising administering a therapeutically effective amount of a quaternary ammonium compound of formula I to a mammal in need of such a treatment, wherein the compound of formula I has the structure



and any stereoisomers thereof, wherein

R_1 is selected from C_1-C_6 alkyl, -CH_2-(C_1-C_4 alkenyl), and –CH_2-(C_1-C_6 alkynyl), each of which is optionally substituted with a group selected from phenyl, C_1-C_4 alkoxy, and hydroxyl; and

X represents an anion of a pharmaceutically acceptable acid.